GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

January 1984

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2.5 hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination. A chemistry data booklet is provided for your reference. Approved calculators may be used.

There are 55 multiple-choice questions and three written-response questions on this examination.

GENERAL INSTRUCTIONS

For multiple-choice questions, read each carefully and decide which of the choices best completes the statement or answers the question. Locate that question on the answer sheet and fill in the space that corresponds to your choice. Use an HB pencil only.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. English

Answer Sheet

A	B	C	D
●	○	○	○

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read carefully and write your answer in the space provided.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1984

1. 50 g of $H_2O_{(g)}$ possess

   A. more kinetic energy than 50 g of $H_2O_{(s)}$
   B. less potential energy than 50 g of $H_2O_{(s)}$
   C. the same total energy as 50 g of $H_2O_{(l)}$
   D. less kinetic energy than 50 g of $H_2O_{(l)}$

2. Energy added to matter during a phase change is stored as

   A. kinetic energy
   B. potential energy
   C. ionization energy
   D. nuclear energy

Use the following information to answer question 3.

A student listed the characteristics of a phase change:

I Kinetic energy and temperature were changing.
II The new phase had a different amount of energy from that of the old phase.
III Potential energy was increased in fusion and in vaporization.
IV Potential energy was decreased during freezing and condensation.

3. The correct characteristics are

   A. I, II, and III
   B. I, II, and IV
   C. I, III, and IV
   D. II, III, and IV

---

4. The ΔH value for a reaction is negative if

   A. the reaction is exothermic
   B. the reaction is endothermic
   C. energy is absorbed during the reaction
   D. the products have a larger heat content than do the reactants

5. The burning of natural gas to heat a home is an example of

   A. a phase change
   B. a decomposition reaction
   C. a chemical change
   D. an endothermic reaction

6. The heat evolved in the reaction, $NH_{3(g)} + \frac{7}{4}O_{2(g)} \longrightarrow NO_{2(g)} + \frac{3}{2}H_2O_{(g)}$, is

A. 254 kJ
B. 283 kJ
C. 348 kJ
D. 374 kJ

Use the following information to answer question 7.

A student follows the procedure outlined below:

I Record the temperature of 30 mL of water in a beaker.
II Add a pellet of $NaOH_{(s)}$ to the water.
III Stir until there is no solid left.
IV Record the final temperature of the water.

7. Which prediction could be tested with the data collected by ONLY these four steps?

A. An exothermic reaction will occur when $NaOH_{(s)}$ is added to $H_2O_{(l)}$.
B. The molar heat of reaction for $NaOH_{(s)}$ with $H_2O_{(l)}$ will be -28.4 kJ/mol.
C. The solubility of $NaOH_{(s)}$ will decrease as the temperature of the water increases.
D. The temperature change will be greater if more $NaOH_{(s)}$ is used.

---

8. When a piece of strontium is dropped into water, the temperature of the water increases. The statement that correctly interprets this information is

A. $Sr_{(s)} + 2H_2O_{(l)} + 434\text{ kJ} \longrightarrow Sr(OH)_{2(aq)} + H_{2(g)}$
B. heat is absorbed by the reaction
C. the reaction is endothermic
D. the reactants have more potential energy than do the products

Use the following information to answer question 9.

$$2C_2H_{6(g)} + 7O_{2(g)} \longrightarrow 4CO_{2(g)} + 6H_2O_{(g)} \qquad \Delta H = -2502 \text{ kJ}$$

9. The number of moles of $CO_{2(g)}$ produced when 1500 kJ of heat are released is

A. 2.4 mol
B. 3.2 mol
C. 6.7 mol
D. 7.6 mol

---

10. The set of compounds that requires energy to be broken down into elements is

A. C_6H_6, $CaCO_3$, NO_2
B. C_6H_6, $CaCO_3$, SO_3
C. HI, $CaCO_3$, SO_3
D. Al_2O_3, $CaCO_3$, H_2SO_4

11. If 4.00 mol of $NH_{3(g)}$ are decomposed according to the equation $NH_{3(g)} + 46.2 \text{ kJ} \longrightarrow \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}$, the heat absorbed is

A. 11.6 kJ
B. 46.2 kJ
C. 92.4 kJ
D. 185 kJ

12. When propene, C_3H_6, burns in air to produce carbon dioxide and water vapor, the heat of combustion is -1.30×10^3 kJ/mol. The molar heat of formation for propene is

A. +665 kJ/mol
B. −606 kJ/mol
C. −738 kJ/mol
D. −1906 kJ/mol

13. In the reaction, $CH_3OH(l) + \frac{3}{2}O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$, if 6.40 g of CH_3OH is burned, the heat evolved is

A. 145 kJ
B. 240 kJ
C. 727 kJ
D. 1200 kJ

Use the following information to answer question 14.

I $H_2O(g) \longrightarrow H_2O(l)$

II $^2_1H + {}^2_1H \longrightarrow {}^4_2He$

III $H_2O(g) \longrightarrow H_2O(s)$

IV $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$

14. The equations arranged in order from lowest to highest heat of reaction are

A. I, III, IV, II
B. IV, I, II, III
C. III, I, IV, II
D. II, I, III, IV

Use the following information to answer question 15.

2.0 g of $NaOH_{(s)}$ were added to 100 mL of water at 20.0°C. After the NaOH dissolved, the temperature of the solution reached 25.0°C.

15. The amount of heat absorbed by the water was

A. 0.020 kJ
B. 0.34 kJ
C. 1.7 kJ
D. 2.1 kJ

---

16. 1.6 g of $NaOH_{(s)}$ is dissolved in 200 mL of $H_2O_{(l)}$. The temperature of the solution increases by 2.0°C. The heat released per mole of NaOH dissolving is

A. 1.1 kJ
B. 1.7 kJ
C. 42 kJ
D. 170 kJ

Use the following information to answer question 17.

In a simple experiment to determine the heat of combustion of ethanol, the mass of a burner containing ethanol was determined, the burner was lit and placed under an aluminum can containing water. The temperature increase of the water was determined and the mass of the burner was again measured. The heat of combustion was determined. The result was much higher than values obtained by accurate calorimetry.

17. The high results obtained were predictable if there was

A. heat loss around the sides of the aluminum can
B. a thermometer touching the bottom of the can
C. evaporation of ethanol from the burner after the first mass determination but before lighting
D. evaporation of ethanol from the burner after extinguishing the flame and before the second mass measurement

---

Use the following information to answer question 18.

A student, in determining the molar heat of fusion of ice, obtained the following data:

Mass of water in calorimeter	200.0 g
Final temperature of water and melted ice in calorimeter	19.8°C
Initial temperature of water in calorimeter	21.6°C
Initial temperature of ice added	0.0°C
Mass of ice added	3.60 g

18. Ignoring the heat absorbed by the calorimeter, the molar heat of fusion of ice is

A. 5.5 kJ/mol
B. 6.0 kJ/mol
C. 7.5 kJ/mol
D. 8.8 kJ/mol

---

19. The Arrhenius definition of an acid states that an acid

A. acts as a proton acceptor
B. acts as a proton donor
C. releases hydroxide ions in solution
D. releases hydrogen ions in solution

Use the following information to answer question 20.

$$H_2CO_{3(aq)} + SO_3^{2-}{}_{(aq)} \rightleftharpoons HCO_3^-{}_{(aq)} + HSO_3^-{}_{(aq)}$$

20. The two acids in this reaction are

A. $SO_3^{2-}{}_{(aq)}$ and $HCO_3^-{}_{(aq)}$
B. $HCO_3^-{}_{(aq)}$ and $HSO_3^-{}_{(aq)}$
C. $H_2CO_{3(aq)}$ and $HCO_3^-{}_{(aq)}$
D. $H_2CO_{3(aq)}$ and $HSO_3^-{}_{(aq)}$

---

21. An acidic solution may be operationally defined as one that

A. is nonelectrolytic
B. reacts with zinc
C. neutralizes CH_3COOH
D. tastes bitter

22. An acid is defined as being strong if it

A. has a high pH
B. has a low $[H_3O^+_{(aq)}]$
C. ionizes completely
D. ionizes very little

23. An indicator acquiring a pink color in a solution with pH = 10 could be

A. red litmus
B. methyl orange
C. phenolphthalein
D. all of the above

24. A solution of an unknown substance has $[H_3O^+_{(aq)}] = 4 \times 10^{-8}$ mol/L. If HCl solution is added drop by drop, the pH

A. increases and the solution becomes more basic
B. decreases and the solution becomes more basic
C. increases and the solution becomes more acidic
D. decreases and the solution becomes more acidic

25. A solution of 0.0300 mol/L $HCl_{(aq)}$ has a pH of

A. 2.48
B. 2.00
C. 1.52
D. 0.480

Use the following information to answer question 26.

Two samples of a solution were tested for pH using methyl red and methyl orange. The observations are shown below.

INDICATOR	COLOR
methyl orange	yellow
methyl red	red

26. The pH of the solution could be

A. 2.3
B. 4.5
C. 5.3
D. 7.5

---

27. An unknown two-proton acid is titrated against a standardized sodium hydroxide solution. The two endpoints are determined and are found to occur at pH values of 6.3 and 4.0. The two indicators that could be used to determine the endpoints are

A. phenolphthalein and methyl red
B. bromothymol blue and methyl orange
C. phenol red and orange IV
D. methyl red and phenol red

28. In a 0.20 mol/L $HNO_{3(aq)}$ solution, the concentration of the hydroxide ion is

A. 5.0×10^{-14} mol/L
B. 2.0×10^{-14} mol/L
C. 5.0×10^{-7} mol/L
D. 1.0×10^{-7} mol/L

29. $NaOH_{(s)}$ is added to bromothymol blue in the acid form (HBb).
The Brønsted-Lowry net ionic equation that represents the reaction is

A. $OH^-_{(aq)} + HBb_{(aq)} \rightleftharpoons BbOH_{(aq)} + H^+_{(aq)}$
B. $OH^-_{(aq)} + HBb_{(aq)} \rightleftharpoons Bb^-_{(aq)} + H_2O_{(l)}$
C. $NaOH_{(aq)} + HBb_{(aq)} \rightleftharpoons NaH_{(aq)} + BbOH_{(aq)}$
D. $NaOH_{(aq)} + HBb_{(aq)} \rightleftharpoons NaBb_{(aq)} + H_2O_{(l)}$

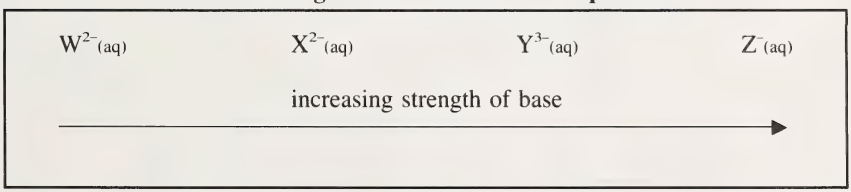
30. During a titration, a 25 mL sample of $HCl_{(aq)}$ of unknown concentration was titrated with 0.20 mol/L $NaOH_{(aq)}$. The equivalence point was reached after 20.5 mL of $NaOH_{(aq)}$ were added. The concentration of the $HCl_{(aq)}$ was calculated and found to be

A. 0.25 mol/L
B. 0.20 mol/L
C. 0.16 mol/L
D. 0.010 mol/L

31. If 0.1 mol/L solutions are prepared for each of the following, which will have the highest conductivity?

A. H_2S
B. HOCl
C. H_2CO_3
D. HF

Use the following information to answer question 32.



32. The strongest acid is

A. $HY^{2-}_{(aq)}$
B. $HX^{-}_{(aq)}$
C. $HW^{-}_{(aq)}$
D. $HZ_{(aq)}$

---

33. 275 mL of 0.400 mol/L HCl was titrated with 100 mL of $KOH_{(aq)}$ to reach the endpoint. The concentration of the $KOH_{(aq)}$ was

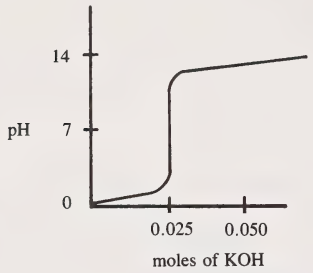
A. 0.400 mol/L
B. 0.800 mol/L
C. 1.10 mol/L
D. 2.20 mol/L

34. The Brønsted-Lowry bases in the reaction,
$HCO_3^-(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + CO_3^{2-}(aq)$, are

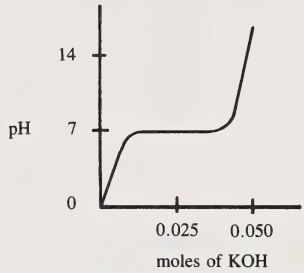
A. $CO_3^{2-}(aq)$ and $OH^-(aq)$
B. $HCO_3^-(aq)$ and $H_2O(l)$
C. $HCO_3^-(aq)$ and $OH^-(aq)$
D. $H_2O(l)$ and $CO_3^{2-}(aq)$

35. KOH solution is gradually added to 50 mL of 0.50 mol/L HNO_3 solution. Which of the following graphs best shows the relationship between pH and moles of KOH?

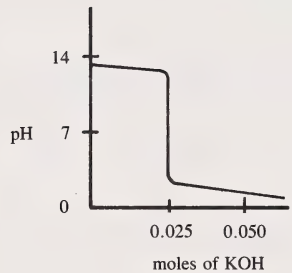
A.



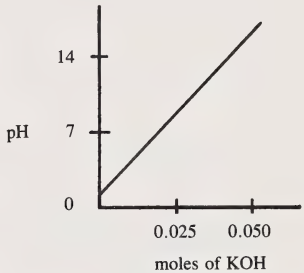
B.



C.



D.



36. The reaction that favors products is

A. $H_2CO_3(aq) + F^-(aq) \rightleftharpoons HF(aq) + HCO_3^-(aq)$
B. $HS^-(aq) + Cl^-(aq) \rightleftharpoons HCl(aq) + S^{2-}(aq)$
C. $HSO_4^-(aq) + NO_2^-(aq) \rightleftharpoons HNO_2(aq) + SO_4^{2-}(aq)$
D. $NH_3(aq) + HCN(aq) \rightleftharpoons NH_4^+(aq) + CN^-(aq)$

37. In an oxidation-reduction reaction,

A. the species that is oxidized gains electrons
B. reducing agents lose electrons
C. oxidizing agents undergo oxidation
D. all oxidizing agents are on one side of the equation

38. A piece of magnesium metal is dipped into an aluminum nitrate solution. The net balanced ionic equation for the reaction is

A. $Mg_{(s)} + Al^{3+}_{(aq)} + 3e^- \longrightarrow Mg^{2+}_{(aq)} + Al_{(s)} + 2e^-$
B. $Mg_{(s)} + Al^{3+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + Al_{(s)}$
C. $3Mg_{(s)} + 2Al^{3+}_{(aq)} \longrightarrow 3Mg^{2+}_{(aq)} + 2Al_{(s)}$
D. $2Mg_{(s)} + Al^{3+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + 3Al_{(s)}$

39. Reduction potentials are relative numbers. The half-reaction on which all reaction potentials are based is

A. $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$ $E^\circ = 0.00$ V
B. $AuCl^-_{4(aq)} + 3e^- \longrightarrow Au_{(s)} + 4Cl^-_{(aq)}$ $E^\circ = +1.00$ V
C. $Li^+_{(aq)} + e^- \longrightarrow Li_{(s)}$ $E^\circ = -3.00$ V
D. $O_{2(g)} + H_2O_{(l)} + 4e^- \longrightarrow 4OH^-_{(aq)}$ $E^\circ = +0.40$ V

40. Predict which metal could be used to construct a storage container for an $AgNO_3$ solution.

A. Tin
B. Iron
C. Gold
D. Copper

Use the following information to answer question 41.

In the electrolysis of Na_2SO_4 solution with copper electrodes, the following half-reactions occur:

cathode: $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

anode: $2Cu_{(s)} + H_2O_{(l)} \longrightarrow Cu_2O_{(s)} + 2H^+_{(aq)} + 2e^-$

41. When 0.0015 mol of $H_2(g)$ is produced at the cathode, the mass of copper oxide formed at the anode is

A. 0.021 g
B. 0.21 g
C. 2.1 g
D. 21 g

Use the following information to answer questions 42 to 44.

$$3MnO_{2(s)} + 12H^{+}_{(aq)} + 2Fe_{(s)} \longrightarrow 3Mn^{2+}_{(aq)} + 6H_2O_{(l)} + 2Fe^{3+}_{(aq)}$$

42. Identify the strongest oxidizing agent in the above reaction.

A. $MnO_{2(s)}$, $H^{+}_{(aq)}$
B. $Fe_{(s)}$
C. $Mn^{2+}_{(aq)}$
D. $Fe^{3+}_{(aq)}$

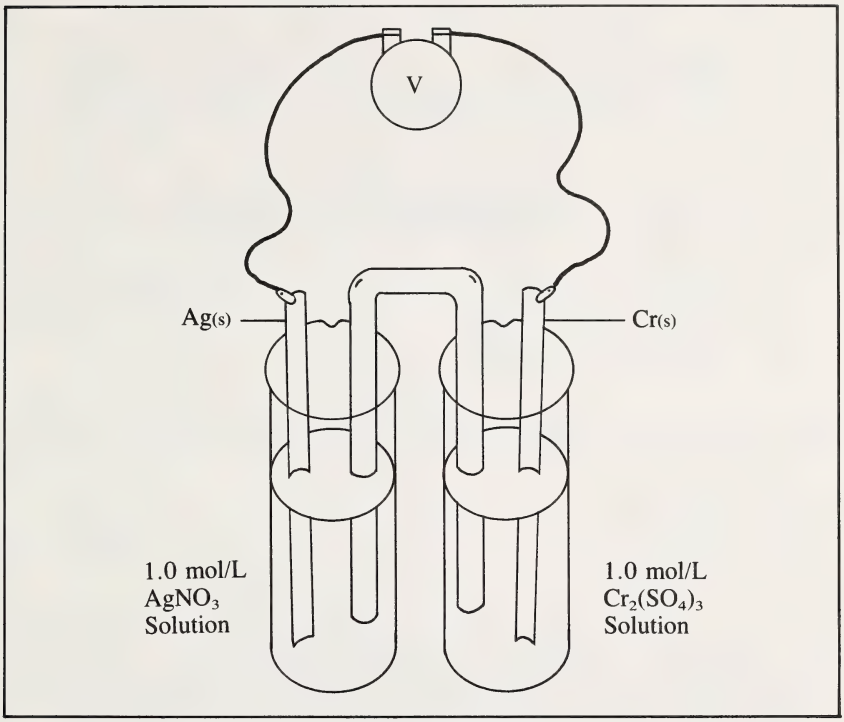
43. How many moles of $MnO_{2(s)}$ are required to react with 1.00×10^{-1} mol of $Fe_{(s)}$?

A. 1.00×10^{-1} mol
B. 1.50×10^{-1} mol
C. 3.00×10^{-1} mol
D. 6.67×10^{-1} mol

44. The number of moles of electrons exchanged per mole of $MnO_{2(s)}$ is

A. 2 mol
B. 3 mol
C. 5 mol
D. 6 mol

Use the following information to answer questions 45 and 46.



45. The reading on the voltmeter is

A. 0.06 V
B. 0.39 V
C. 1.21 V
D. 1.54 V

46. During the operation of the cell

A. $SO_4^{2-}{}_{(aq)}$ ions migrate through the salt bridge
B. electrons flow from $Ag_{(s)}$ to $Cr_{(s)}$
C. $Cr^{3+}{}_{(aq)}$ ions are formed
D. the electrode $Ag_{(s)}$ is oxidized

47. Which of the following pairs would undergo a spontaneous redox reaction?

A. $K^{+}_{(aq)}$ and $NO_{2(g)}$
B. $I_{2(s)}$ and $Cl^{-}_{(aq)}$
C. $Sn^{2+}_{(aq)}$ and $Fe^{3+}_{(aq)}$
D. $SO_{2(g)}$ and $Cr^{3+}_{(aq)}$

48. Predict which of the following is most likely to occur when nickel, $Ni_{(s)}$, is placed in a solution containing $Br_{2(l)}$, $Br^{-}_{(aq)}$, and $Zn^{2+}_{(aq)}$.

A. $2Br^{-}_{(aq)} \longrightarrow Br_{2(l)} + 2e^{-}$
B. $Br_{2(l)} + 2e^{-} \longrightarrow 2Br^{-}_{(aq)}$
C. $Zn^{2+}_{(aq)} + 2e^{-} \longrightarrow Zn_{(s)}$
D. There will be no reaction.

49. The ion that will oxidize $Cu_{(s)}$ to $Cu^{2+}_{(aq)}$, but will not oxidize $Br^{-}_{(aq)}$ to $Br_{2(l)}$, is

A. $Zn^{2+}_{(aq)}$
B. $2H^{+}_{(aq)}$
C. $Co^{2+}_{(aq)}$
D. $Ag^{+}_{(aq)}$

50. Which of the following occurs in an electrochemical cell?

A. Anions migrate towards the cathode.
B. Cations migrate towards the cathode.
C. Reduction occurs at the anode.
D. Electrons flow through the electrolyte.

51. In the reaction, $Cr^{3+}_{(aq)} + Al_{(s)} \longrightarrow Al^{3+}_{(aq)} + Cr_{(s)}$, the substance that is oxidized is the

A. chromium ion
B. chromium solid
C. aluminum ion
D. aluminum solid

52. In an electrochemical cell

A. oxidation occurs at the cathode
B. oxidation occurs at the anode
C. electrons move from the cathode to the anode
D. the strongest reducing agent reacts at the cathode

53. In which of the following does the reactant lose electrons?

A. $I_{2(s)}$ goes to $I^{-}_{(aq)}$.
B. $Sn^{4+}_{(aq)}$ goes to $Sn^{2+}_{(aq)}$.
C. $H^{+}_{(aq)}$ goes to $H_{2(g)}$.
D. $Fe^{2+}_{(aq)}$ goes to $Fe^{3+}_{(aq)}$.

54. The E^{0}_{net} for a zinc-silver electrochemical cell is

A. +1.56 V
B. +0.04 V
C. −0.04 V
D. −1.56 V

55. Electrochemical cells differ from electrolytic cells in that

A. electrochemical cell potentials are positive and electrolytic cell potentials are negative
B. electron flow is from anode to cathode in electrochemical cells and from cathode to anode in electrolytic cells
C. anions migrate to the anode in electrochemical cells and to the cathode in electrolytic cells
D. cations migrate to the cathode in electrochemical cells and to the anode in electrolytic cells

THANK YOU FOR COMPLETING THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION.
PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

WRITTEN RESPONSE

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Show all pertinent calculations and formulas, and give your answers to the correct number of significant figures.

(USE FOR ROUGH WORK ONLY)

1. $C_3H_7OH_{(l)}$ was completely burned to $CO_{2(g)}$ and $H_2O_{(g)}$ in the bomb of a bomb calorimeter. The data obtained are tabulated below:

Volume of water surrounding the bomb	750 mL
Temperature of water surrounding the bomb before the reaction	20.5°C
Temperature of water surrounding the bomb after the reaction	38.2°C
Mass of $C_3H_7OH_{(l)}$ burned	30.1 g

(1 mark) **a.** Calculate the heat gained by the water surrounding the bomb.

(2 marks) **b.** Calculate the molar heat of reaction for $C_3H_7OH_{(l)}$.

(1 mark) **c.** Write a balanced equation for the reaction.

(1 mark) **d.** Calculate the ΔH for the equation in part **c.**

(2 marks) **e.** Calculate the molar heat of formation of $C_3H_7OH_{(l)}$.

(USE FOR ROUGH WORK ONLY)

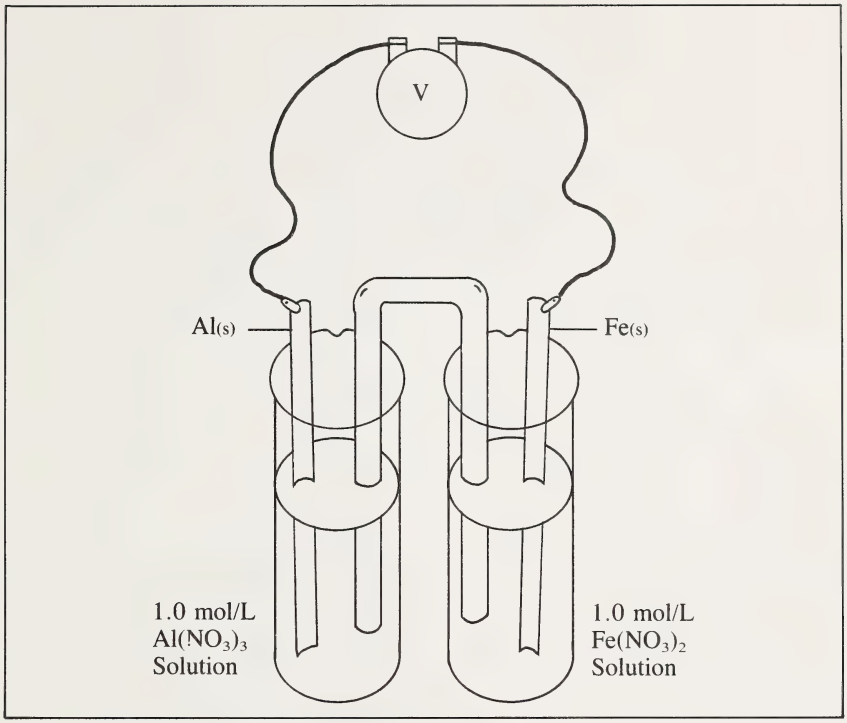
2. A 25.0 mL sample of 0.145 mol/L acetic acid was titrated to the endpoint with a 0.250 mol/L sodium hydroxide solution using phenolphthalein as an indicator.

(1 mark) **a.** Write the Brønsted-Lowry net ionic equation for the reaction.

(2 marks) **b.** Determine the volume of sodium hydroxide required.

(USE FOR ROUGH WORK ONLY)

3.



(1 mark) **a.** Predict the voltmeter reading assuming standard conditions and negligible internal resistance.

(1 mark) **b.** Write the equation for the half-reaction that would occur at the iron electrode.

(2 marks) **c.** If 0.050 mol of electrons passes through the cell and the original mass of the aluminum electrode was 9.82 g, predict the final mass of the aluminum electrode.

(1 mark) **d.** Predict which metal ion concentration would increase as the cell operates.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

FOR DEPARTMENT USE ONLY

M1 M2 M3

FOR DEPARTMENT USE ONLY

(LAST NAME) (FIRST NAME)

NAME:

Y M D

DATE OF BIRTH: SEX:

SCHOOL CODE: SCHOOL: _____

CITY: _____

SIGNATURE: _____

FOR DEPARTMENT USE ONLY